Amendments to the Claims

This listing of claims will replace all prior versions and listings of claims in the above-identified application:

Listing of Claims

Claim 1 (Currently amended): A position detecting apparatus that detects a position of an object, comprising:

a position sensor that outputs a plurality of position detecting signals which have different phases respectively that change periodically according to a movement of the object;

a phase converting unit that generates a plurality of phase converted signals, from the plurality of position detecting signals, which have different phases respectively by giving each predetermined phase difference to the plurality of position detecting signals;

a first calculating unit that obtains first position data corresponding to a position of the object on the basis of the plurality of position detecting signals;

a second calculating unit that obtains second position data corresponding to a position of the object on the basis of the plurality of phase converted signals generated by the phase converting unit; and

a third calculating unit that obtains a position of the object on the basis of the first position data and the second position data.

Claim 2 (Original): The position detecting apparatus according to claim 1, further comprising:

a plurality of phase converting units that generates a plurality of phase converted signals by giving phase differences, which are respectively different, to the position detecting signals; and

a plurality of second calculating units that obtains each of a plurality of second position data on the basis of the phase converted signals generated by each of the plurality of phase converting units,

wherein the third calculating unit obtains a position of the object on the basis of the first position data and the plurality of second position data.

Claim 3 (Original): The position detecting apparatus according to claim 2, wherein the following condition is satisfied:

$$P = P_0 \pm (1/2)^n \times P_0$$

where P_0 denotes one phase difference out of the plurality of phase differences, P denotes each of the other phase differences, and n is a integral number larger than 1.

Claim 4 (Original): The position detecting apparatus according to claim 3, wherein the phase difference P0 is 45°.

Claim 5 (Original): The position detecting apparatus according to claim 1, wherein the plural phases of position detecting signals are constituted of four phases of signals, that is, a sine wave, a cosine wave, and positive and negative signals obtained by reversing their polarity.

Claim 6 (Original): The position detecting apparatus according to claim 2, wherein the respectively different plural phase differences are phase differences that are changed at the same interval.

Claim 7 (Original): The position detecting apparatus according to claim 2, wherein the respectively different plural phase differences are 22.5°, 45°, and 67.5°.

Claim 8 (Original): The position detecting apparatus according to claim 1, wherein the position sensor comprises a magnetic member periodically magnetized, and a magnetic detector

that relatively moves with the magnetic member in connection with the movement of the object and outputs a plurality of position detecting signals according to a magnetic change due to the movement of the object.

Claim 9 (Original): The position detecting apparatus according to claim 1, wherein the position sensor comprises an optical scale member having a reflecting surface whose shape periodically changes, and an optical detector that relatively moves with the optical scale member in connection with the movement of the object and outputs a plurality of position detecting signals according to quantity of received light from light, which is reflected on the optical scale member that changes due to the movement, among light irradiated to the optical scale.

Claim 10 (Original): An optical apparatus comprising:

an optical system; and

the position detecting apparatus according to claim 1 that detects a position of at least one optical element in the optical system..

Claim 11 (Currently amended): A position detecting method that detects a position of an object, comprising:

a first step of outputting a plurality of position detecting signals which have different phases respectively that change periodically according to a movement of the object;

a second step of generating a plurality of phase converted signals, from the plurality of position detecting signals, which have different phases respectively by giving predetermined phase differences to the plurality of position detecting signals;

a third step of obtaining first position data corresponding to a position of the object on

the basis of the plurality of position detecting signals;

a fourth step of obtaining second position data corresponding to a position of the object on the basis of the plurality of phase converted signals generated in the second step; and

a fifth step of obtaining a position of the object on the basis of the first position data and the second position data.

Claim 12 (Original): The position detecting method according to claim 11, wherein a plurality of phase converted signals is generated at the second step by giving phase differences, which are respectively different, to the position detecting signals;

wherein each of a plurality of second position data is obtained on the basis of each of the plurality of phase converted signals at the fourth step; and

wherein a position of the object is obtained on the basis of the first position data and the plurality of second position data at the fifth step.

Claim 13 (Currently amended): An image reading apparatus comprising:

an image sensing unit that senses an object image;

an optical unit adapted to focus the object image;

a position sensor that outputs a plurality of position detecting signals which have different phases respectively that change periodically according to a movement of the object;

a phase converting unit that generates a plurality of phase converted signals, from the plurality of position detecting signals, which have different phases respectively by giving each predetermined phase difference to the plurality of position detecting signals;

a first calculating unit that obtains first position data corresponding to a position of the optical unit on the basis of the plurality of position detecting signals;

a second calculating unit that obtains second position data corresponding to a position of the optical unit on the basis of the plurality of phase converted signals generated by said phase converting unit; and

a third calculating unit that obtains a position of the optical unit on the basis of the first position data and the second position data,

wherein the image sensing unit senses the object image in the position obtained by the third calculating unit.